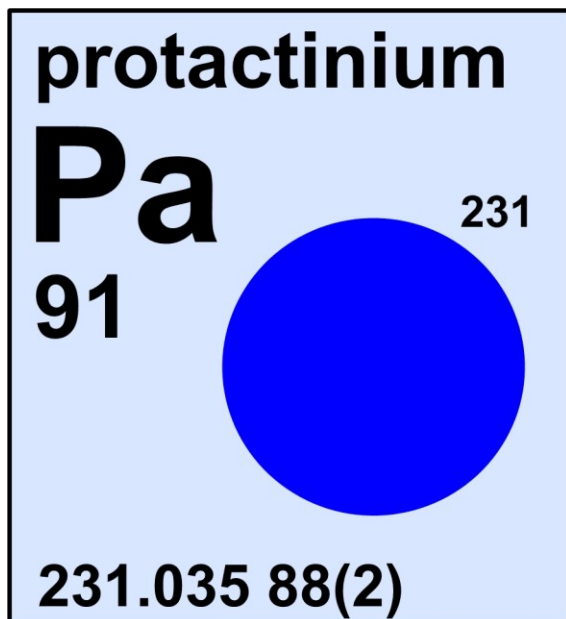


## protactinium



Stable isotope	Atomic mass*	Mole fraction
$^{231}\text{Pa}$	231.035 884	1.0000

\* Atomic mass given in unified atomic mass units, u.

### Half-life of radioactive isotope

Less than 1 second  
 Between 1 second and 1 hour  
 Greater than 1 hour



$^{212}\text{Pa}$	$^{213}\text{Pa}$	$^{214}\text{Pa}$	$^{215}\text{Pa}$	$^{216}\text{Pa}$	$^{217}\text{Pa}$	$^{218}\text{Pa}$	$^{221}\text{Pa}$	$^{222}\text{Pa}$	$^{223}\text{Pa}$
$^{224}\text{Pa}$	$^{225}\text{Pa}$	$^{226}\text{Pa}$	$^{227}\text{Pa}$	$^{228}\text{Pa}$	$^{229}\text{Pa}$	$^{230}\text{Pa}$	$^{231}\text{Pa}$	$^{232}\text{Pa}$	$^{233}\text{Pa}$
$^{234}\text{Pa}$	$^{235}\text{Pa}$	$^{236}\text{Pa}$	$^{237}\text{Pa}$	$^{238}\text{Pa}$	$^{239}\text{Pa}$	$^{240}\text{Pa}$			

## Important applications of stable and/or radioactive isotopes

### Isotopes in geochronology

- 1)  $^{231}\text{Pa}$  is a natural radiogenic isotope produced by alpha decay of  $^{235}\text{U}$  to  $^{231}\text{Th}$ , followed by beta emission to form  $^{231}\text{Pa}$ . Although its behavior in the environment as a transient member of the U-series decay chain may be complex, measurements and modeling of  $^{231}\text{Pa}$  in relation isotopes of U and Th can be used in a variety of geochronologic applications on time scales of  $10^3$  to  $10^5$  years.
  - a. Studies include movement of water masses and particles in the oceans, rates of magma melting and movement beneath volcanoes, ages of carbonate mineral deposits including corals in relation to climate change.

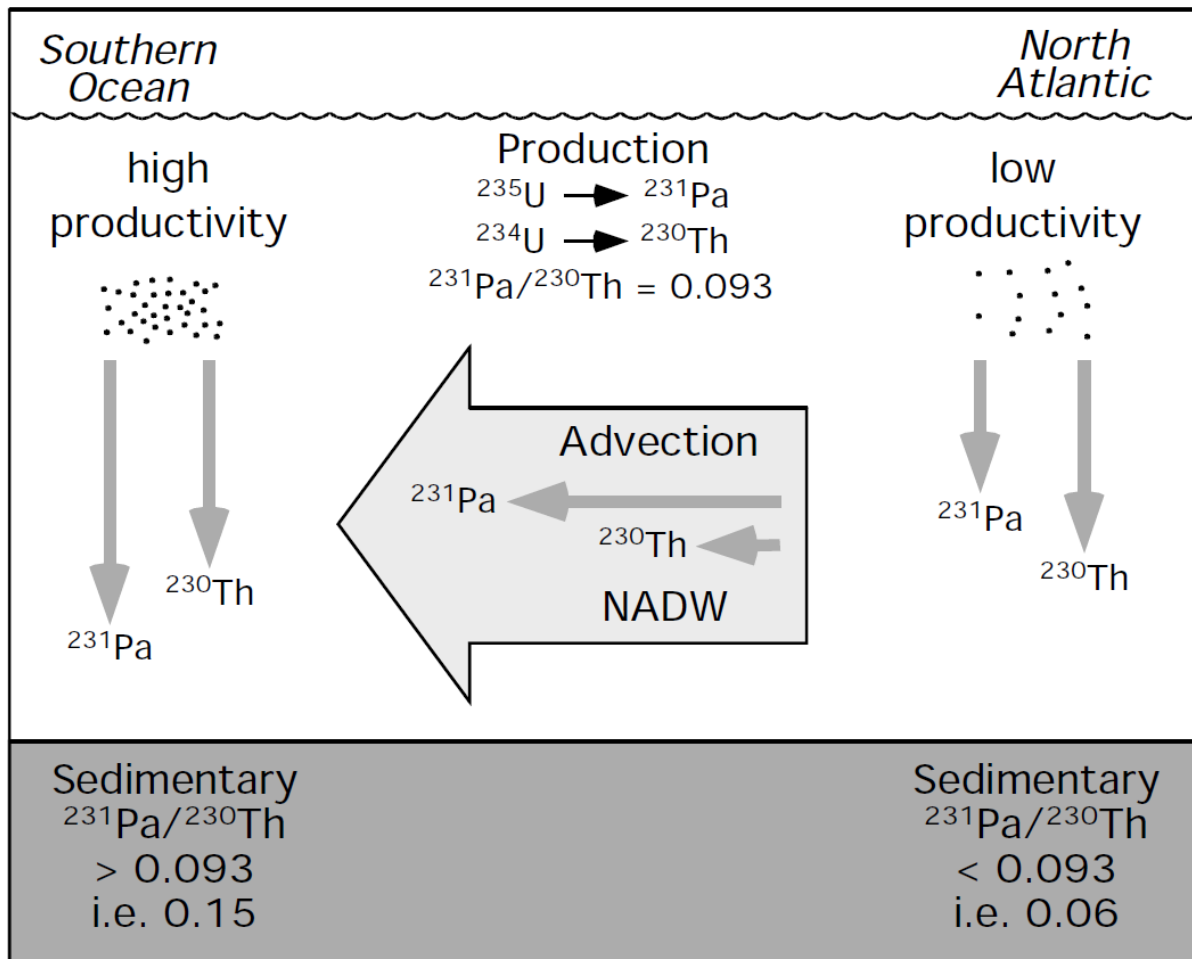


Figure 1: Diagram of  $^{231}\text{Pa}$  -  $^{230}\text{Th}$  fractionation in the oceans. (Diagram Source: Henderson and Anderson, 2003).